Examiner : Vanessa T. Velasquez
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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant(s) : H. ASAHI et al.

Appln. No. : 10/588,837

Filed : August 8, 2006

For : STEEL PLATE OR STEEL PIPE WITH SMALL OCCURRENCE OF BAUSCHINGER EFFECT AND METHODS OF PRODUCTION OF SAME

DECLARATION UNDER 37 C.F.R. §1.132

SIR:

I, Hitoshi ASAHI, a citizen of Japan, declare as follows:

I. Background

(1). I am a co-inventor of the invention(s) disclosed and claimed in the above-identified patent application.

(2). I am an employee of Nippon Steel Corporation, Tokyo, Japan. Nippon Steel Corporation, Tokyo, Japan is the assignee of the above-identified patent application.

(3). I received a Master Degree from Osaka University Graduate School, Japan in March 1981. I received a Doctor of Engineering from Osaka University, Japan in March 1994.

(4). Since April, 1981, I have been employed by Nippon Steel Corporation, Tokyo, Japan, engaged in pipe and tube research and development. I am currently Chief Researcher (pipe-tube) in the Steel Research Laboratories of Nippon Steel Corporation.

(5). I can read and understand the English language. I can read and understand the Japanese language.

(6). I have read and understand the specification, claims and drawings of the above-identified patent application and specifically claims 7 to 12 currently under consideration in the above-identified patent application. I have read and understand the prior art of record in the above-identified patent application and, specifically, Japan No. 10-176239 to Kashima et al. and Bates et al. "Quenching of Steel," Vol. 4, Heat Treating, ASM Handbooks On Line, ASTM International, 2002, (49 pages total), particularly pages 1 to 5 of 49, Fig. 42(b) and Fig. 43.

(7). In the Office Action mailed September 9, 2009, claims 7 to 12 of the above-identified patent application were finally rejected under 35 U.S.C. §103(a) as being unpatentable over Japan No. 10-176239 to Kashima et al. in view of Bates et al. ("Quenching of Steel", Vol. 4, ASM Handbooks On Line), specifically citing at page 3, last line, of the Office Action Bates et al. at pages 1 to 5 of 49 and Fig. 42(b) and Fig.43.

(8). The Advisory Action mailed February 18, 2010, maintained the final rejection of claims 7 to 12 over Japan No. 10-176239 to Kashima et al. in view of Bates et al. The Advisory Action stated that the comparison data of Figures A, B and C (submitted with the Amendment Under Rule 116 filed January 26, 2010, Certificate of Mailing dated January 22, 2010) should be submitted in the form of a Declaration under 37 C.F.R. §1.132.

II. The Present Invention

(1). The invention of the present application is directed to a steel pipe for use in oil wells or gas wells which exhibits a small drop in compression strength in the circumferential direction after the steel pipe has been expanded in the circumferential direction, i.e., a small occurrence of the Bauschinger effect. Specification, page 1, lines 10 to 14.

(2). The phenomenon called the "Bauschinger effect" is well known to those skilled in the art. In this phenomenon, if tensile stress is applied to a steel article in a given direction to cause plastic deformation, and then compressive stress is applied in the opposite direction, tensile stress reapplied in the original direction causes plastic deformation to occur at a lower stress than the original yield strength. Specification, page 1, lines 24 to 29. The invention of the present application is directed to minimizing the Bauschinger effect in the circumferential direction when the steel pipe has been expanded (tensile stress) in the circumferential direction.

(3). In recent years, technology has been developed wherein a steel pipe used in oil or gas wells is expanded 10 to 30% after drilling (expandable tubular technology). This expandable tubular technology reduces drilling costs by expanding the steel pipe which has been inserted into the well after drilling. The expansion of the steel pipe introduces high tensile stress in the circumferential direction. The ground introduces a high circumferential compressive stress in the opposite direction. Therefore, the Bauschinger effect on the steel pipe in such situations has become an issue. Specification, page 2, lines 29 to 36. The invention of the present application is directed to providing a steel pipe that has a small occurrence of the Brauschinger effect.

(4). In the present invention, a steel pipe with a small occurrence of the Bauschinger effect is fabricated from a steel plate comprising a steel base material containing, by mass %, C: 0.03 to 0.30%, Si: 0.01 to 0.8%, Mn: 0.3 to 2.5%, P: 0.03% or less, S: 0.01% or less, Al: 0.001 to 0.1%, N: 0.01% or less, and a balance of iron and unavoidable impurities. The steel base material

has a dual-phase structure substantially comprising ferrite structure and fine martensite dispersed at the ferrite grain boundaries.

After the steel plate is shaped into the steel pipe, the steel pipe is heated at the austenite-ferrite dual-phase temperature region and then quenched.

The steel pipe is a seam welded ERW steel pipe having a uniform thickness.

The ratio of proportional limit of the compression stress-strain curve in the circumferential direction of the steel pipe before expansion of the steel pipe and after expansion of the steel pipe by introduction of 10 to 30% of strain is 0.7 or more.

The ratio of the proportional limit is (PL-a)/(PL-b), where (PL-a) is the proportional limit yield strength after expansion of the steel pipe, and (PL-b) is the proportional limit yield strength before expansion of the steel pipe using a 0.05% offset yield strength.

(5). The ratio of the proportional limit, (PL-a)/ (PL-b), is called the "Bauschinger effect ratio". The higher this value, the smaller is the occurrence of the Bauschinger effect. Specification, page 8, lines 5 to 8.

(6). The steel pipe of the present invention, having a small occurrence of the Bauschinger effect, is a steel pipe wherein, after a steel plate is shaped into the steel pipe, the steel pipe is heated at the austenite-ferrite dual-phase temperature region and then quenched.

III. The Prior Art

(1). Cited Japan No. 10-176239 (hereinafter "JP '239") discloses a steel plate having a steel composition similar to the steel composition of the present invention for use in the manufacture of a steel plate which can be shaped into a steel pipe.

(2). JP '239 does not disclose or suggest that after a steel plate is shaped into a steel pipe, the steel pipe is heated at the austenite-ferrite dual-phase temperature region and then quenched.

(3). Bates et al. ("Quenching of Steel, Vol. 4, ASM Handbooks On Line, pages 1 to 5 of 49, Fig. 42(b) and Fig. 43) was cited in the Office Action mailed September 9, 2010 at page 3 for disclosing that water is a convenient and pollution-free means to quench steel and that it is capable of creating cooling rates within the range taught by Kashima et al., i.e., JP '239.

(4). Bates et al. does not disclose or suggest that <u>after</u> a steel plate is shaped into a steel pipe, the steel pipe is heated at the austenite-ferrite dual-phase temperature region and then quenched.

(5). Therefore, neither JP '239 nor Bates et al. discloses or suggests that <u>after</u> a steel plate is shaped into a steel pipe, the steel pipe is heated at the austenite-ferrite dual-phase temperature region and then quenched.

(6). The steel pipe product of the present invention, having a small occurrence of the Bauschinger effect, has a heat history (<u>after</u> the steel plate is shaped into a steel pipe, the steel pipe is heated at the austenite-ferrite dual phase temperature region and then quenched) that is not disclosed or suggested in JP '239 and/or Bates et al. The steel pipe product of the present invention is very different from a steel pipe disclosed or suggested by JP '239 in view of Bates et al.

<u>IV. Comparative Tests</u>

(1). Attached hereto are Fig. A, Fig. B and Fig. C.

(a). Fig. A is a stress-strain diagram for a stress-strain test for a steel pipe in accordance with the present invention.

(b). Fig. B is a stress-strain diagram for a stress-strain test for a steel plate in accordance with the present invention and JP '239.

(c). Fig. C is a stress-strain diagram for a stress-strain test for a steel pipe in accordance with JP '239.

(d). The X-axis or strain axis for Fig. A, Fig. B and Fig. C are the same. In Fig. A, the X-axis or strain axis is expressed as %. In Fig. B and C, the X-axis or strain axis is expressed as a non-dimensional decimal. It is readily apparent that the X-axis or strain axis of Fig. A, Fig. B and Fig. C are the same.

(2). (a). A steel plate was produced having the following composition in mass %: C: 0.086 %; Si: 0.21%; Mn: 1.19%; P: 0.018%; S: 0.006%; Al: 0.03%; N: 0.0035%, and a balance of iron and unavoidable impurities.

(b). The steel plate was produced by heating a slab at 1,230°C; hot rolling at a finish temperature of 870°C; cooling at a cooling rate of 20°/second; then coiling at a coiling temperature of about 550°C.

(c). The steel base material of the steel plate had a dual phase structure substantially comprising a ferrite structure and fine martensite dispersed at the ferrite grain boundaries. The fine martensite had an area ratio of 15%.

(3). (a). <u>Fig. A</u> attached hereto. A steel pipe was fabricated from the steel plate of IV. (2). <u>After</u> the steel pipe was fabricated from the steel plate, the steel pipe was heated at the austenite-ferrite dual-phase temperature region and then quenched. This is a steel pipe in accordance with the present invention.

(b). A test piece from the steel pipe, in accordance with the present invention of IV (3) (a)., was subjected to a stress-strain test. <u>Fig. A</u>, attached hereto, shows that the steel pipe, in accordance with the present invention, which after being shaped into a pipe and then heated at the austenite-ferrite dual phase temperature region and then quenched, <u>absorbs additional stress</u> from a load <u>after</u> reaching the yield point stress (i.e., exhibits plastic deformation or plastic working).

(c). <u>Fig. A</u> shows that the steel pipe of the present invention (specific heat treatment and then quenching after the steel plate is shaped into the steel pipe) does <u>not</u> begin to fracture after reaching the yield point stress. The steel pipe of the present invention exhibits plastic

working after reaching the yield point stress. Fig. A shows that the steel pipe of the present invention continues to absorb stress after reaching the yield point stress.

(4). (a). Fig. B, attached hereto, is a stress-strain diagram for the steel plate of IV. (2). This is the steel plate of the present invention and this steel plate also will be referred to in this Declaration as the steel plate of JP '239.

(b). A test piece of the steel plate of IV. (2). was subjected to a stress-strain test. Fig. B, attached hereto, shows that a steel plate in accordance with the present invention and a steel plate of JP '239 each absorb additional stress from a load after reaching the yield point stress (i.e., exhibit plastic deformation or plastic working).

(5). (a). Fig. C attached hereto. For Fig. C, a steel pipe was fabricated from the steel plate of IV. (2) in substantially the same way as the steel pipe of IV. (3). (a). The steel pipe of Fig. C was not heat treated and then quenched after the steel pipe was fabricated from the steel plate. Fig. C is a steel pipe which will be referred to in this Declaration as a steel pipe of JP '239 which has not been heat treated and then quenched after the steel plate is shaped into the steel pipe.

(b). A test piece from the steel pipe of IV. (5). (a), i.e., a steel pipe of JP '239, was subjected to a stress-strain test substantially the same as the stress-strain test of the test piece of the steel pipe test piece in accordance with the present invention in IV. (3). (b). Fig. C, attached hereto, shows that the steel pipe of JP '239, which was not heat treated and then quenched after being shaped into a pipe does not absorb additional stress from a load after reaching the yield point stress (i.e., exhibits no plastic working or plastic deformation).

(c). Fig. C shows that a steel pipe of JP '239 (no heat treatment and then quenching after the steel plate is shaped into a steel pipe) begins to fracture immediately after reaching the yield point stress and does not exhibit plastic working. Fig. C shows that the stress absorbed by a steel pipe of JP '239 becomes a maximum at about the yield point stress, and then there is failure.

V. Conclusion

(1). A comparison of Fig. A (the present invention) and Fig. C (JP '239) shows that steel pipes shaped from substantially similar steel plates but having been subjected to different heat histories after the steel plate is shaped into the steel pipe (present invention-specific heat treatment after shaping the steel plate into the steel pipe; JP '239 no heat treatment after shaping the steel plate into the steel pipe) are steel pipe products which exhibit very different stress-strain characteristics.

(2). An object of the present invention is to provide a steel pipe with a small occurrence of the Bauschinger effect.

(3). Fig. A demonstrates that the steel pipe of the present invention will provide a small occurrence of the Bauschinger effect after the steel pipe has been expanded (subjected to circumferential tensile stress) in applications such as oil and gas wells.

(4). Fig. C demonstrates that the steel pipe of JP '239 will not provide a small occurrence of the Bauschinger effect after the steel pipe has been expanded (subjected to circumferential tensile stress) in applications such as oil and gas wells.

Declaration

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Respectfully submitted,

Hitoshi Asahi

Hitoshi ASAHI

July 28, 2010

Date

ATTACHMENT

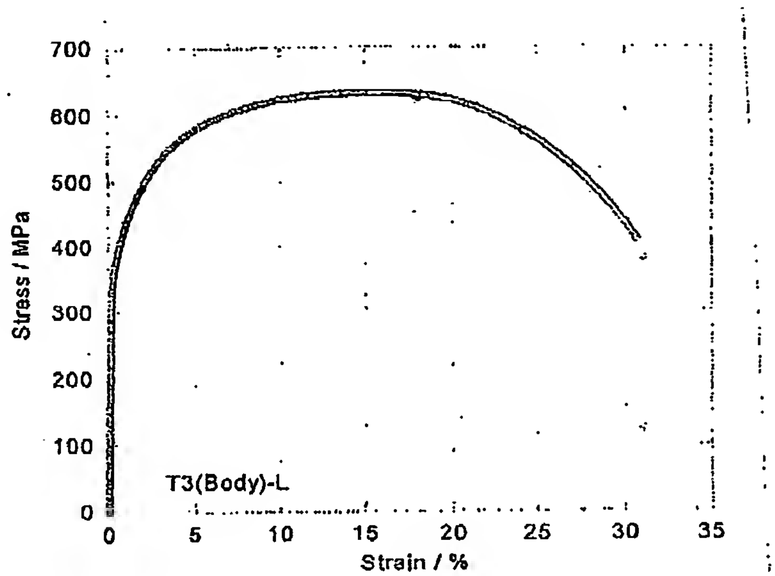

Fig. A

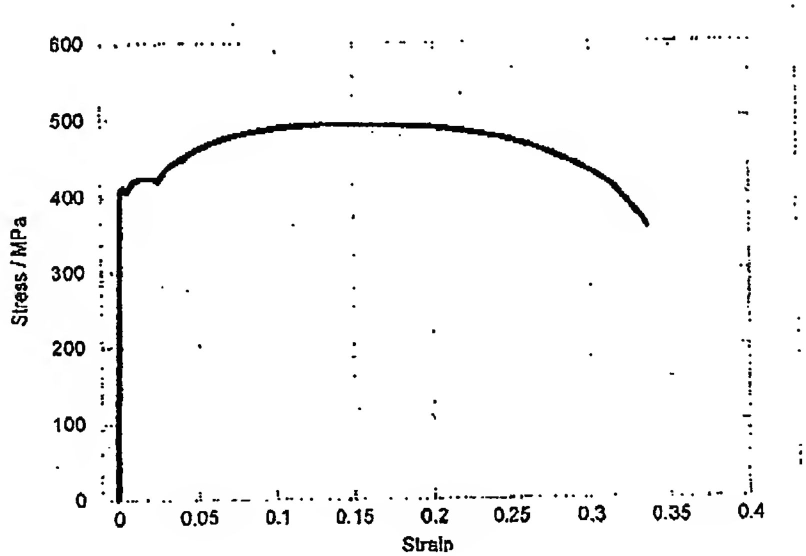

Fig. B

ATTACHMENT

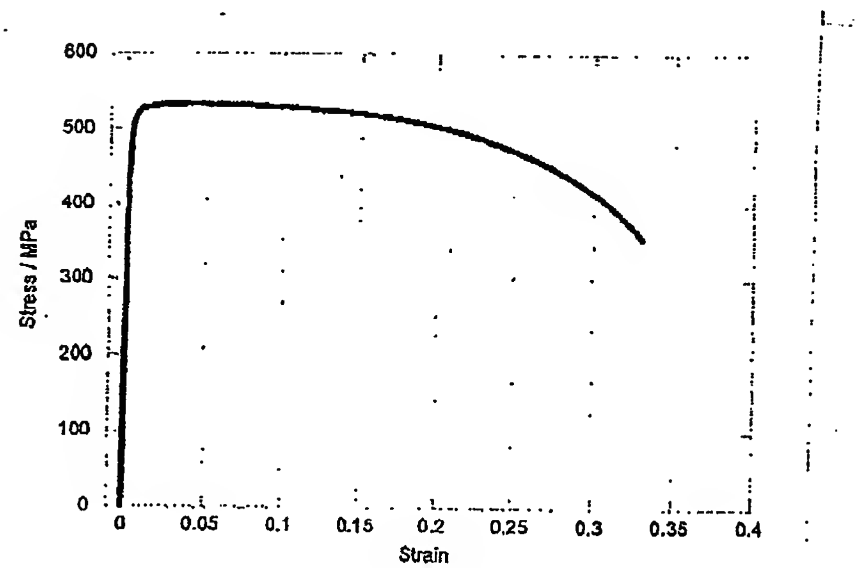

Fig. C